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EXECUTIVE SUMMARY

COMPACTABLE REACTOR WASTE CHARACTERIZATION

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A two-year project to characterize compactable reactor wastes in respect of physical composition, β/γ activity, radionuclide inventory and tritium and carbon-14 content was undertaken for Nuclear Materials Management Department to assess the suitability of this waste for disposal with or without further conditioning. During the study 1072 bags of waste from normal maintenance operations at Pickering and Bruce GS were examined. The bags produced 18 bales of compacted waste with a volume of 9 m^3.

Compactable wastes probably have the most varied composition of any class of reactor waste and probably any material used at a nuclear generating station could be present at one time or another. Paper and plastic (PVC suits, etc) represent about 70% of the waste by volume. The remainder could consist of materials such as sweeping compound, vermiculite, rubber, fibreglass, metal pieces, etc.

The waste is generally of low activity; 84% of the bags had contact dose rates less than 1 mr/h and only 1% exceeded 100 mr/h. β/γ activity of the bales ranged between 1.0 and 6.94 mCi most of which was contributed by radionuclides with a half-life of one year or less. After ten years' decay the β/γ activity will have decreased to not more than 1.5 mCi per bale all attributable to ^{60}Co and ^{137}Cs.

Approximately 11% of the bags exhibited visible moisture and analysis of both "wet" and "dry" bags gave positive results in most cases for tritium and carbon-14. It is estimated that 1 m^3 of compacted waste could contain 8.4 to 11.3 Ci of tritium and 0.8 to 5.4 μCi of carbon-14.

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It is considered that compactable waste will not require further conditioning for disposal although ventilation during operation of the disposal facility may require special attention because of the tritium.

It is recommended that compactable waste from the Pickering retubing operation should be similarly characterized to determine changes in activity levels and radionuclide inventories associated with unusual maintenance activities.

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COMPACTABLE REACTOR WASTE CHARACTERIZATION

A.S. Williamson

Compactable reactor wastes were characterized in respect of physical composition, β/γ activity levels, radionuclide inventory, and tritium and carbon-14 content. 1072 bags of waste representing 18 bales with a volume of 9 m^3 were examined. This waste is extremely heterogeneous and can contain any item or material used at nuclear generating stations. The β/γ activity level of the waste is low; at the time of manufacture the 18 bales ranged between 1.0 and 6.94 mCi most of which was attributable to radionuclides with a half-life of one year or less. After ten years' decay the activity of any bale will have decreased to a maximum of 1.5 mCi and the only β/γ radionuclides of significance will be ^{60}Co and ^{137}Cs. Tritium and carbon-14 were found in most of the waste bags and it is estimated that a cubic metre of waste could contain 8.4 to 11.3 Ci of tritium and 0.8 to 5.4 μCi carbon-14. It is considered there is no need for further conditioning of this waste for disposal.

Compactable reactor wastes arising from the operation of Ontario Hydro's nuclear generating stations amount to a volume of about 2000 m^3/year at present. This volume could increase to approximately 6500 m^3/year by 1990 if a reactor waste disposal facility is in operation as it is planned to discontinue incineration if the disposal option is adopted.

Compactable reactor waste consists of incinerable waste with a bag contact dose rate greater than 60 mr/h plus a heterogeneous mixture of

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plastic, paper, and other materials. The waste is shipped to BNFDS in plastic bags which are compacted into cardboard bales of approximately 0.5 m^3 capacity at the waste Volume Reduction Facility. After manufacture the bales are wrapped in plastic sheet and stored in the Low Level Waste Storage Building.

The compactable waste characterization research project undertaken in support of the Nuclear Materials Management Department's Reactor Waste Disposal Program, involved assessment of the physical composition and measurement of activity levels and radionuclide inventory of the waste. In addition, tritium and carbon-14 contents were measured in selected bags of waste and the data used to estimate the probable levels of these radionuclides in the waste.

Characterization:
Bags

1072 bags of compactable waste were examined for physical composition, presence of moisture, contact dose rate, and mass. Tritium and carbon-14 determinations were made on 51 bags selected from the bags suspected of containing water. Eight (8) "dry" bags were also analyzed for tritium.

The waste was of extremely heterogeneous composition as shown by the example of individual bag data in Appendix 1. Most of the bags contained plastic and paper in varying amounts together with other miscellaneous materials. The plastic waste consisted of PVC suits, sheet plastic and plastic hoses. The miscellaneous component of the waste could be almost any material. Sweeping compound, vermiculite, fibreglass insulation, metal pieces, electrical cable and rubber boots and gloves were frequently present. Occasionally cans and glass and plastic bottles containing oils and aqueous liquids were found.

Contact dose rates of all bags were measured and the percentage distribution by dose rate was found to be as follows:

84%	<1 mr/h
10%	1-10 mr/h
5%	11-100 mr/h
1%	>100 mr/h

122 bags contained visible moisture in the form of pools of liquid or condensation on the inside of the bag. 51 bags were selected on the basis of tritium content of the air in the bag for extraction of tritium and carbon-14 from the waste. The contents of each bag were placed into a sack and sodium hydroxide solution recirculated through the waste for 24 h to elute any tritium and carbon-14 in the waste.

Tritium levels obtained from the extracted bags ranged from a low of 100 µCi to a high of 9.3 Ci with the summary distribution shown in Table 1.

TABLE 1

Tritium Activity Distribution in Waste Bags

Tritium Level	No of Bags	% of Total
100-500 µCi	11	22
501-999 µCi	9	18
1-100 mCi	19	38
101-999 mCi	6	12
>1 Ci	5	10
	50	100

Carbon-14 was only found in 42 of the eluates and 90% of these contained less than 100 nCi, the remaining 10% varied between 140 nCi to a high of 4 µCi. There was no correlation between tritium and carbon-14 contents: the 5 bags each containing more than 1 Ci of tritium had less than 100 nCi ^{14}C per bag. Tritium was also found in the 8 "dry" bags at levels between 228 µCi to 4 mCi. Carbon-14 was present in 7 of these bags at levels less than 100 nCi.

Bales

Eighteen (18) 0.5 m^3 bales were produced from the bags of waste that were examined. Bag distribution by physical composition, contact dose rate and moisture was noted for each bale. The contact dose rate for each side of the bale was measured and gamma scans were made to identify the radionuclides present and their activity level.

Typically a bale of compacted waste will contain between 50-70 bags, the number varying according to the extent to which the bags are filled and the compactability of the contents. Because of the heterogeneity of the waste the physical composition of the bale can vary widely. Table 2 gives the maximum, minimum and average volumes of plastic, paper, and other waste for the 18 bales.

TABLE 2

Physical Composition of Bales by Volume

%	Plastic	Paper	Other
Max	62	45	52
Min	25	16	22
Avg	35	28	37

Figure 1 shows the percentage distribution of the bags in the bales by contact dose rate. With one exception, more than 80% of the bags in a bale had contact dose rates of less than 1 mr/h. Seven (7) bales contained bags with a dose rate greater than 100 mr/h however, bags at this level represent less than 4% of the total bags in any bale.

The average activity in millicuries for each bale is presented in Figure 2. Twelve (12) bales measured less than 4 mCi/bale and only 2 exceeded 6 mCi. The β/γ emitting radionuclides found in the bales had half-lives of less than two years with the exception of ^{60}Co and ^{137}Cs. These two radionuclides contributed between 30-90% of the original activity in any bale.

The percentage of bags containing visible moisture in a bale averages about 11%, ie about 7 bags per bale. On the basis of the tritium analyses made on "wet" and "dry" bags it can be reasonably expected that all bales of compactable waste will contain tritiated water. It is also probable that all bales will contain some carbon-14.

DISCUSSION

Compactable wastes probably have the most varied composition of any class of reactor waste and virtually any item or material used at nuclear generating stations could form part of this class of waste. The frequent presence of metal parts and containers holding aqueous or oily liquids indicates in-station waste segregation is not effective.

The radioactivity in compactable waste is low; more than 80% of the bags examined had a contact dose rate of less than 1 mr/h. The maximum rate measured was 2 R/h on one bag; the 1% of bags exceeding 100 mr/h had dose rates around 500 mr/h.

Approximately 11% of the bags contained visible moisture either as condensation on the surface of the plastic or as pools of water. Tritium was found in all the "wet" bags that were analyzed at levels ranging from 100 µCi to 9 Ci. Eight (8) dry bags were analyzed and were also found to contain tritium at between 200 µCi to 4 mCi. Additional tritium was found in bottles containing water which were removed from four bags at levels of 4 µCi to 23 mCi. These positive tritium findings indicate it can be expected to be present in all bags of compactable waste to a greater or lesser extent.

Carbon-14 was only found in about 80% of the wet bags analyzed. Concentrations ranged from 2 nCi to 4 µCi. Carbon-14 was also found in the nanocurie level in 7 of the 8 "dry" bags analyzed.

Detailed data on the 18 bales produced in the course of this study are given in Appendix 2 which presents the bag contact dose rate distribution in each bale, bale contact dose rates and radionuclide inventory.

FIGURE 1

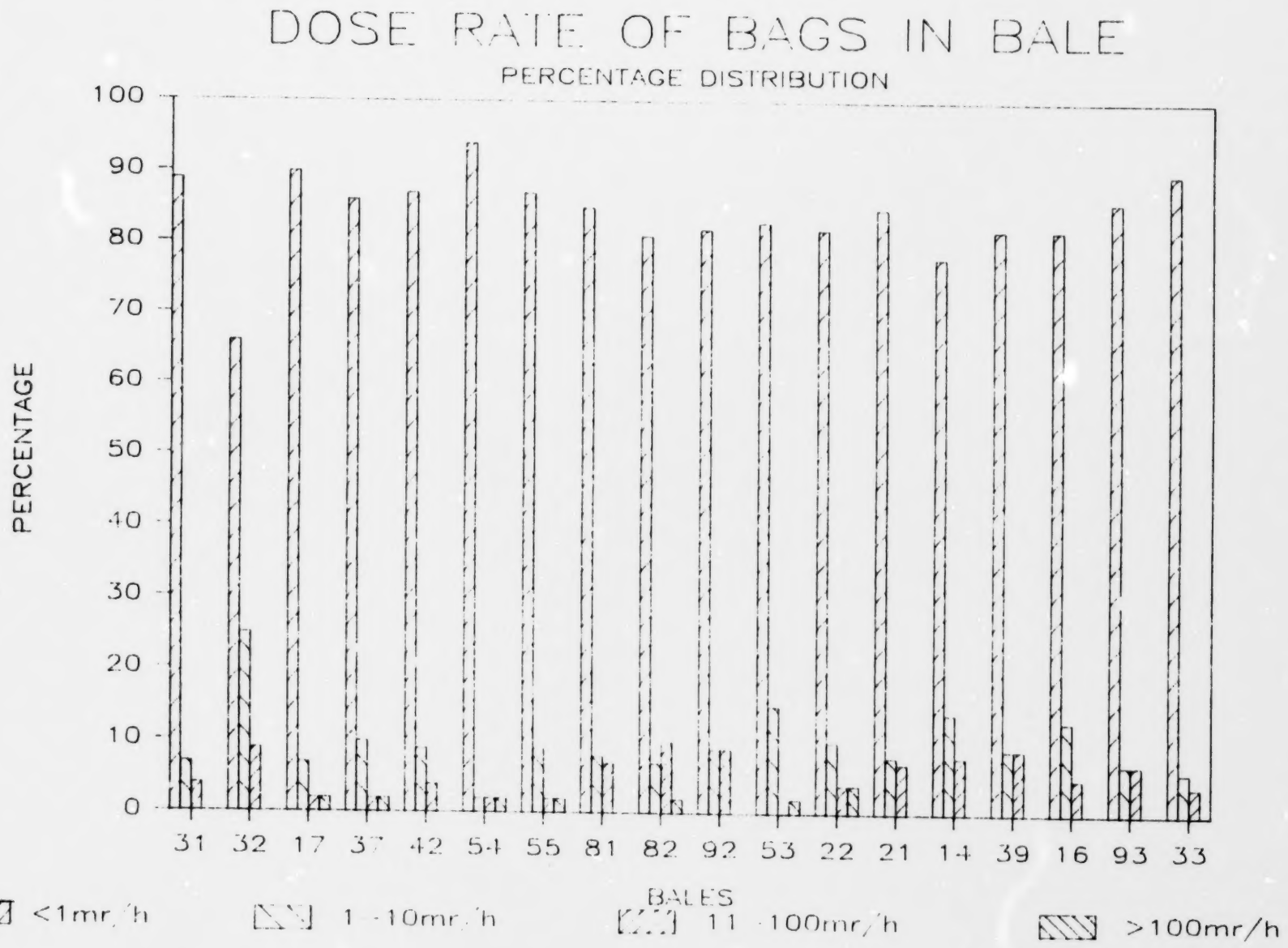
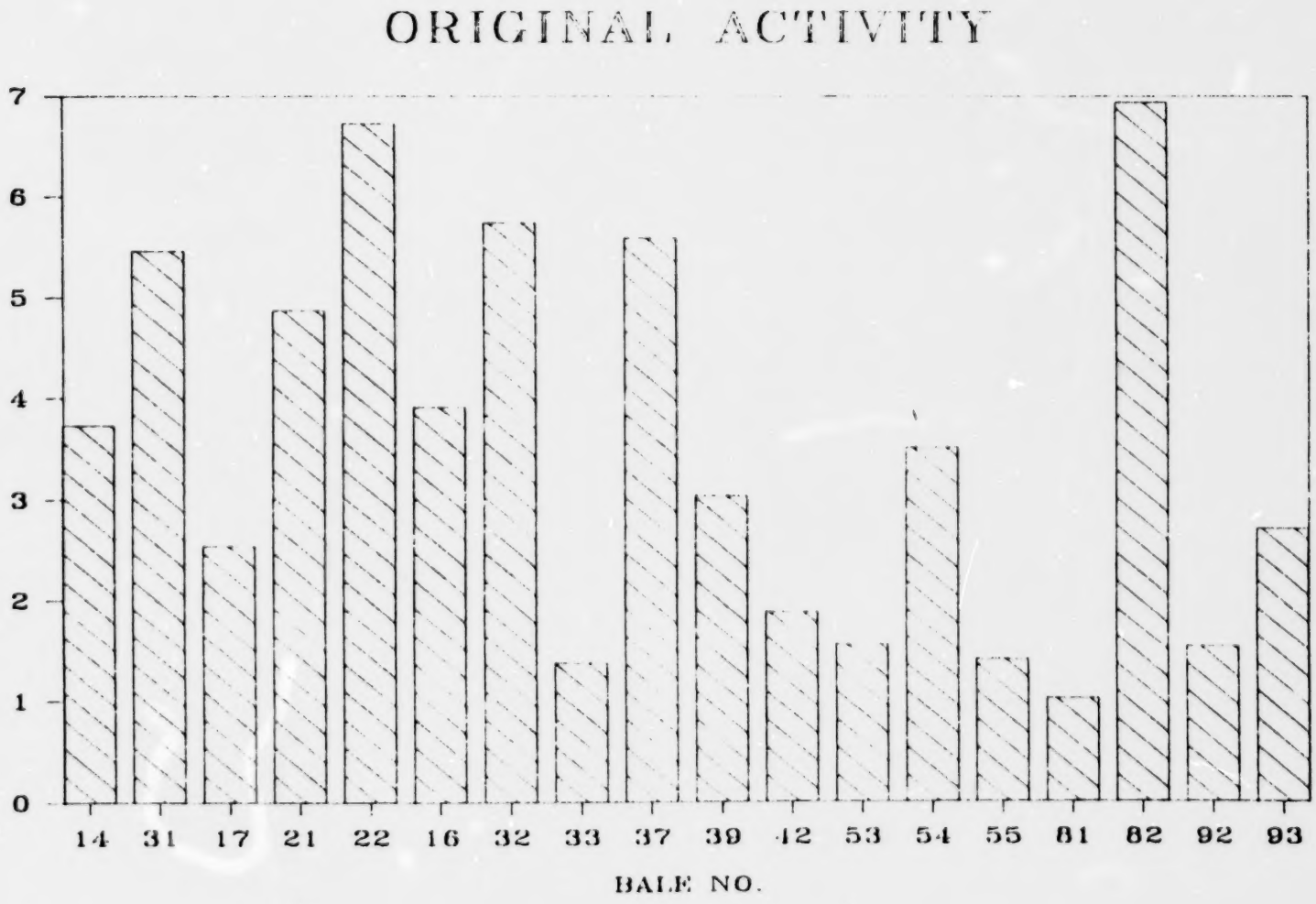

DOSE RATE OF BAGS IN BALE
PERCENTAGE DISTRIBUTION
PERCENTAGE
100
90
80
70
60
50
40
30
20
10
0
31 32 17 37 42 54 55 81 82 92 53 22 21 14 39 16 93 33
BALES
<1mr/h
1 - 10mr/h
11 - 100mr/h
>100mr/h

FIGURE 2



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The bar graphs in Figure 3 illustrate the original β/γ activity in each bale and its decrease with time. These clearly show the low level of the waste; after five years' decay the average β/γ activity will be less than 2.5 mCi and after 10 years this will have decreased further to less than 1.5 mCi in the most active bale. Fourteen (14) bales will actually be below 1 mCi per bale. After ten years' decay the only β/γ radionuclides of any significance in the waste will be ^{60}Co and ^{137}Cs and Figure 4 shows the fractional contribution of these radionuclides to the bale activity at that time.

Tritium can be expected to be present in every bale of waste. The data from tritium extraction of waste bags were statistically analyzed to derive a possible tritium inventory as detailed in Appendix 3 and summarized in Table 3.

TABLE 3

Tritium Inventory in Baled Wastes

No of Bags	Mean $\bar{x}_i$ + SD	Pool Std Dev (Sp)	Overall Mean $^3H \pm CI$
"Wet" 5	6.654±1.81 Ci	±0.5818 Ci	0.7107 Ci±13.3%
27	109.95±180.6 mCi		
19	458.8±275 µCi		
51			
"Dry" 4	3.68±0.43 mCi	$\pm 3.79 \times 10^{-4}$ Ci	2.05 mCi±15.1%
4	422.8±320 µCi		
8			

There were 122 wet bags and 950 dry bags therefore the total tritium content in the 1072 bags equals:

$$122 \times 0.7107 \text{ Ci} + 950 \times 2.05 \text{ mCi} \pm CI_{ov} = 88.653 \text{ Ci} \pm 14.9\%$$

As the bags produced 18 bales or approximately 9 m^3, each cubic metre of compacted waste could contain between 8.4 to 11.3 Ci of tritium. The nature of the waste package, cardboard loosely wrapped in plastic, is such that the tritium can be expected to escape from it by diffusion during storage and/or operation of the disposal facility. In the case of a disposal facility this feature may require special attention to be paid to ventilation to avoid unacceptable worker exposure to tritiated water vapour.

FIGURE 3

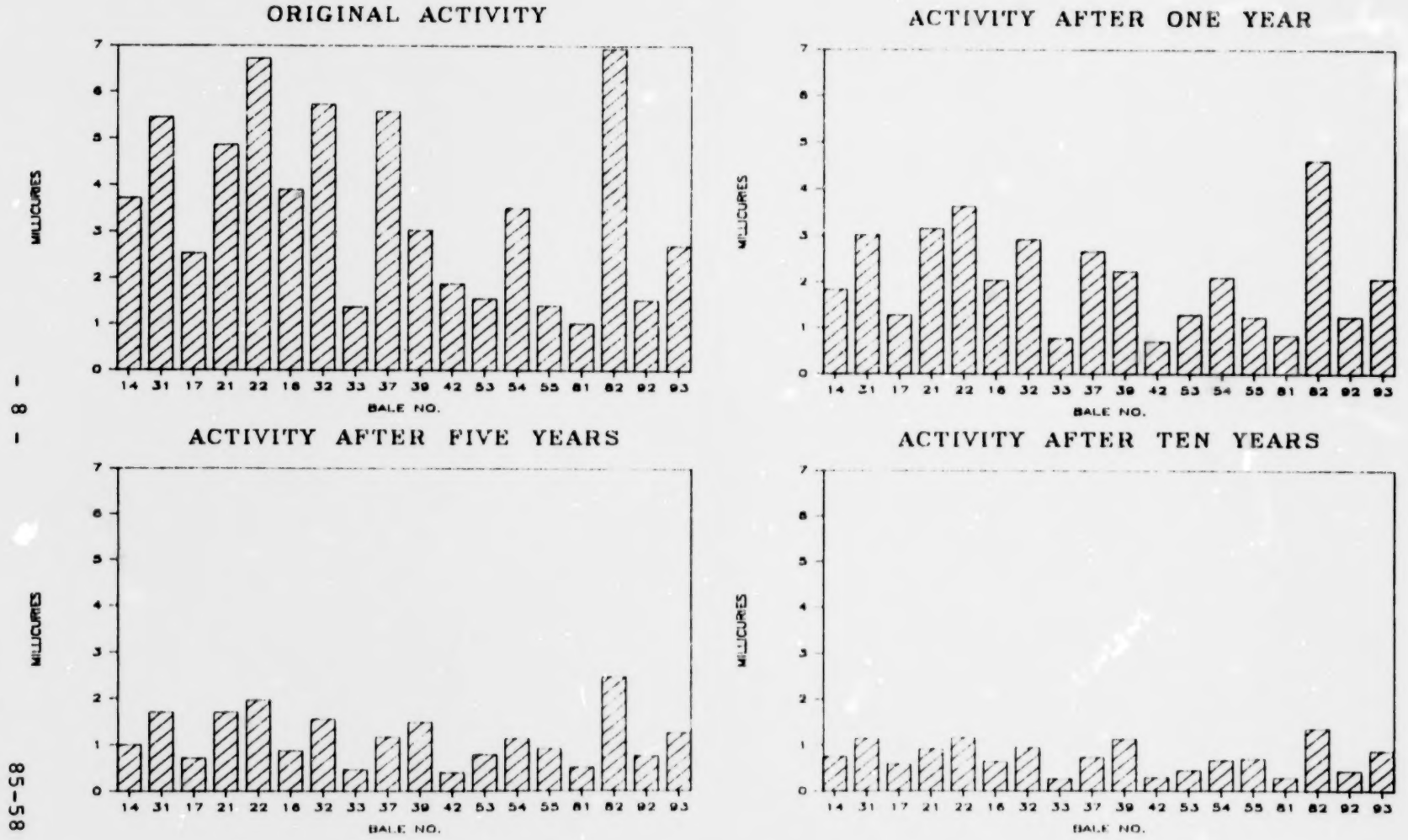
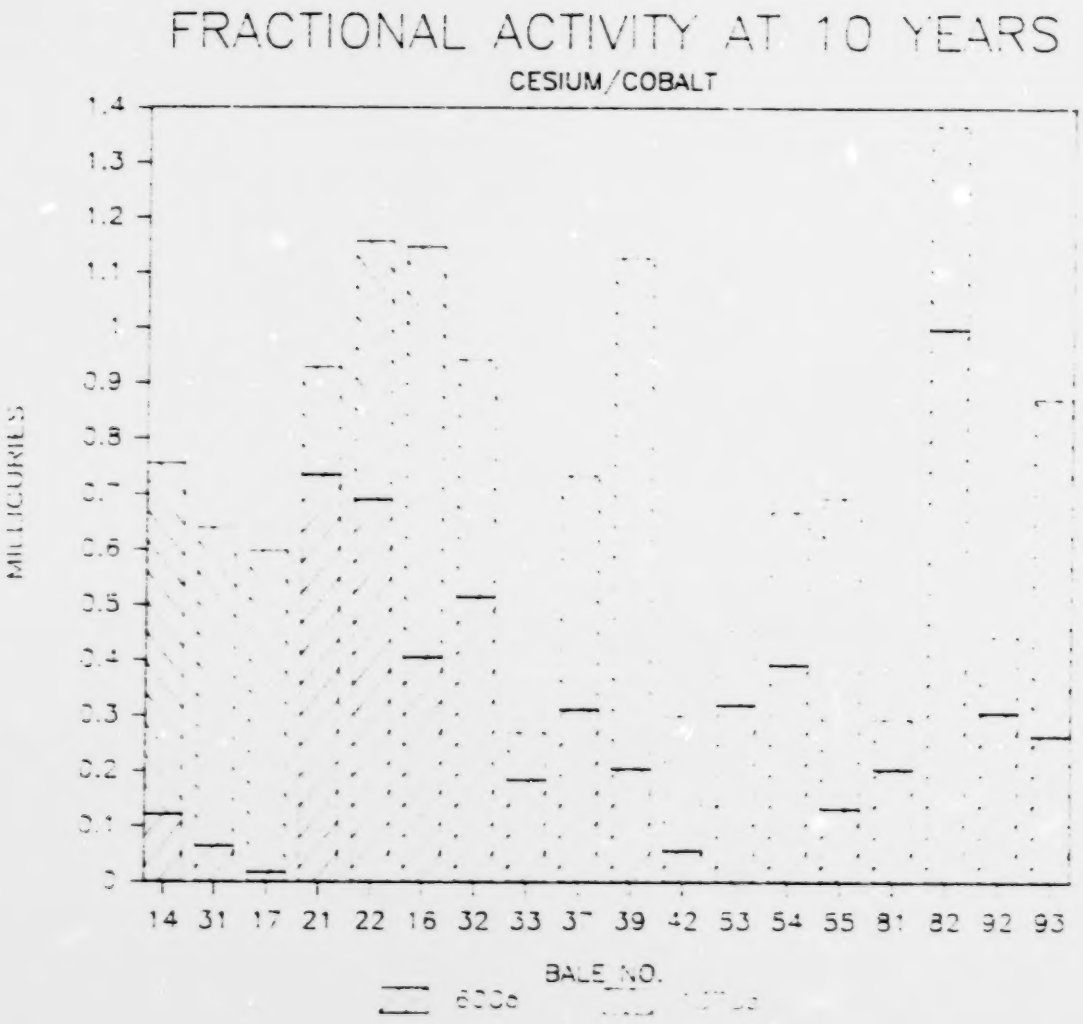

ORIGINAL ACTIVITY
ACTIVITY AFTER ONE YEAR
ACTIVITY AFTER FIVE YEARS
ACTIVITY AFTER TEN YEARS
MILLICURIES
BALE NO.
14 31 17 21 22 16 32 33 37 39 42 53 54 55 81 82 92 93

FIGURE 4


FRACTIONAL ACTIVITY AT 10 YEARS
CESIUM/COBALT
MILLICURIES
1.4
1.3
1.2
1.1
1
0.9
0.8
0.6
0.5
0.3
0.2
0
14 31 17 21 22 16 32 33 39 42 53 54 55 82 92 93
BALE NO.

This excercise was repeated on the carbon-14 data however, the single high value (4.2 μCi ^{14}C) had to be discarded in this case because its inclusion created an overall confidence interval of more than ±100%.

TABLE 4

Carbon-14 Inventory in Baled Wastes

No of Bags	Mean + SD $\bar{x}_1$	Pool Std Dev (Sp)	Overall mean ^{14}C±CI
"Wet" 36 5	28.6±23.1 nCi 340.8±187.5 nCi	±68.96 nCi	66.67 nCi±32.6%
41			
"Dry" 7	25.8±23.3 nCi	±23.3 nCi	25.8 nCi±80.5%

The overall confidence interval calculated from this analysis was ±75% which gave a carbon-14 range between 0.78 and 5.4 μCi per cubic metre of compacted waste. The high overall confidence interval of ±75% is due to the relatively high levels of carbon-14 in the small number of "dry" bags analyzed. If the carbon-14 range is too wide for use in the disposal facility assessment it will be necessary to undertake further analysis of waste bags to improve the data.

CONCLUSIONS

1. The heterogeneity of compactable wastes is such that it is probable any item or material used at Ontario Hydro nuclear generating stations will form part of the waste at some time or another. Even items such as metal parts and bottled liquids which should not be in this class of waste were frequently found in the course of the project.

2. Compactable wastes are generally of low specific activity; 84% of the bags examined had a contact dose rate of less than 1 mr/h and only 1% exceeded 100 mr/h.

3. The positive tritium results from all waste bags analyzed for this radionuclide suggest tritium will be present in most if not all bags of compactable waste. Carbon-14 was found also in most of the analyzed bags.

4. The radionuclide inventory of the 18 bales produced during this study showed most of the β/γ activity was attributable to radionuclides with a half-life of less than one year. After ten

years' decay the only β/γ radionuclides of significance will be ^{60}Co and ^{137}Cs. The maximum average activity in the bales at the time of production was approximately 7 millicuries. After ten years no bale will exceed 1.5 millicuries.

5. The tritium and carbon-14 content of compacted waste was estimated to be between 8.4 to 11.3 Ci/m³ and 0.8 to 5.4 uCi/m³ respectively.

6. The tritium in compacted waste will diffuse readily from the bales during storage or operation of a disposal facility. Special ventilation arrangements may be required to prevent unacceptable worker exposure particularly at the disposal site.

7. The radiological hazard of compactable waste is so low that there is no need for further conditioning of the waste before emplacement in a disposal facility.

RECOMMENDATIONS

1. The characterization of compactable waste covered a time span of approximately two years and it is felt that a good cross section of normal operating waste was studied. A similar characterization of compactable waste arising from the Pickering Units 1 and 2 re-tubing operation should be done to determine the effect on radionuclide inventory, activity levels and composition of unusual maintenance activities. For example, waste from this operation may contain more β/γ activity and would be expected to have little or no tritium and carbon-14 because the heavy water has been removed from the primary heat transport and moderator circuits.

2. Further analysis of "dry" bags of waste for carbon-14 should be made to develop sufficient data to derive a closer estimate of carbon-14 levels in the waste.

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ASW:rv

APPENDIX I

CHARACTERIZATION OF COMPACTABLE RADIOACTIVE WASTES
TYPICAL BAG DATA

Bag	Mass kg	Activity mr/h	Moisture	Composition % Plastic	% Paper	% Other	Comments
1	8.5	30	No	30	40	30	wire, cotton, rubber
2	2.0	100	Slight	10		90	filter
3	8.0	70	No	80	10	10	metal
4	6.0	40	No	10	20	70	jute, cotton mops
5	4.0	50	Slight	40	40	20	rubber gloves
6	4.0	50	Yes	90		10	rubber and cotton gloves
7	4.0	0.5	Yes	100			
8	6.5	0.7	Yes	10	50	40	vermiculite
9	8.5	0.3	Yes	50	40	10	rubber and cotton gloves
10	6.0	0.2	Yes	40	40	20	gloves and towels
11	6.5	0.7	Yes	80		20	vermiculite, rubber
12	11.0	1.0	Yes	60		40	vermiculite, rubber gloves and boots
13	6.5	0.3	Yes	50	20	30	rubber gloves
14	2.5	0.2	Yes		80	20	vermiculite
15	4.0	0.2	Yes		90	10	gloves
16	8.5	0.2	Yes	40	20	40	cotton gloves
17	4.5	0.3	Yes	50		50	cotton mop
18	8.5	2.0	No	70	10	20	cotton and rubber
19	8.0	0.3	No	40	40	20	metal
20	6.5	0.5	No	40	40	20	metal
21	8.0	0.7	No	100			
22	11.5	0.3	No	50	30	20	rubber
23	3.5	0.3	No	50		50	fiberglass insulation, rubber
24	7.5	0.5	No	40	40	20	cotton gloves
25	11.0	0.6	No	30	10	60	mop, metal, rope
26	7.5	0.4	No		30	70	paint cans
27	8.0	0.3	No		30	70	metal welding rod and fittings
28	7.5	0.7	No	60	10	30	cotton gloves, metal
29	2.5	0.3	No		80	20	metal
30	3.5	0.5	No		50	50	metal
31	5.5	0.3	No		40	60	rubber gloves, wire
32	7.0	0.3	No	50	40	10	metal
33	8.0	1.5	No	20	70	10	metal
34	11.0	0.4	No	90		10	metal
35	8.5	0.4	No	10	20	70	styrofoam, metal, sawdust

APPENDIX I (contd)

CHARACTERIZATION OF COMPACTABLE RADIOACTIVE WASTES
TYPICAL BAG DATA

Bag	Mass kg	Activity mr/h	Moisture	Composition % Plastic	% Paper	% Other	Comments
36	5.5	0.7	No	50	50		
37	6.5	0.3	No	60	10	30	rope, metal
38	3.5	0.5	No			100	filters
39	5.0	0.2	No	50	30	20	cotton and vermiculite
40	9.5	0.3	No	20		80	cotton mop and gloves, metal
41	15.0	0.3	No		10	90	wood, floor sweepings
42	3.5	10.0	No		95	5	metal
43	11.5	0.3	No	30	50	20	metal, floor sweepings
44	5.0	0.3	No		30	70	metal foil, rubber gaskets
45	5.0	0.3	No	60	40		
46	5.0	0.5	No	10		90	cotton mop and handle
47	3.5	35.0	No	70	20	10	metal
48	4.0	0.3	No	20		80	metal cladding, fiberglass insulation
49	3.5	0.3	No			100	furnace filters
50	5.0	0.5	Oily			100	rubber boots
51	4.0	0.3	No	30	30	40	cotton
52	7.5	0.2	No	30	30	40	metal, rope, rubber
53	3.5	0.2	No	50	40	10	metal
54	7.0	0.3	No	20		80	metal, cotton gloves
55	10.0	2.0	No	80		20	rubber, metal
56	6.0	0.2	No		100		cardboard box with glass vials
57	7.0	0.2	No	20	40	40	cotton gloves, metal, wood
58	5.0	0.2	No		100		
59	6.0	0.2	No		100		cardboard box with broken glass
60	6.5	3.0	No	90	10		plastic buckets
61	7.0	0.2	No	70	10	20	wood, rubber
62	7.0	0.2	No		40	60	metal, grounding cable
63	6.0	0.4	No	30		70	metal, calcium sulphate pipe insulation
64	10.0	0.2	No			100	metal
65	9.0	0.2	No	40	40	20	metal

APPENDIX I (contd)

CHARACTERIZATION OF COMPACTABLE RADIOACTIVE WASTES
TYPICAL BAG DATA

Bag	Mass kg	Activity mr/h	Moisture	Composition % Plastic	% Paper	% Other	Comments
66	6.0	0.2	No	20		80	metal, rubber
67	5.0	0.2	No	50	40	10	metal
68	7.0	0.2	No	50	50		
69	12.0	0.5	No	100			hose
70	4.0	1.0	No		40	60	metal, calcium sulphate insulation
71	15.0	0.2	No			100	steam hose
72	15.0	0.2	No			100	steam hose
73	10.5	0.3	No	50		50	wood
74	4.0	0.2	No	20		80	cotton gloves, metal
75	5.5	0.3	No	100			plastic buckets
76	3.0	0.2	No			100	furnace filters
77	10.0	0.3	Oily	50		50	rubber hose
78	11.5	4.0	No	20	30	50	metal bucket, welding blanket
79	6.5	0.2	No	20		80	rubber boots
80	8.0	0.3	No	80	10	10	rubber
81	7.0	0.3	No	50		50	metal dust pan
82	5.0	0.3	No	100			
83	7.0	0.2	No	100			
84	15.0	0.3	No	100			plastic mat
85	4.0	0.2	No			100	furnace filters
86	2.0	0.2	No		100		
87	9.0	0.2	No	50		50	rubber, metal
88	9.5	0.3	No	10		90	pipe insulation
89	5.0	0.3	No			100	metal
90	3.0	0.3	No	100			vacuum cleaner hose
91	15.0	0.3	No	70		30	metal
92	8.5	0.2	No	40	20	40	floor sweepings
93	15.0	0.3	No	100			plastic mat
94	6.0	3.0	No	60	20	20	cotton, metal and fiberglass insulation
95	1.0	3.5	No			100	buffing wheels
96	1.0	0.2	No			100	metal
97	8.0	5.0	No		10	90	pipe insulation, metal cladding
99	6.0	0.2	No	20	70	10	wire
99	4.0	0.2	Slight		70	30	pop cans
100	5.0	0.5	No	50	30	20	metal, cotton gloves

APPENDIX I (concluded)

CHARACTERIZATION OF COMPACTABLE RADIOACTIVE WASTES
TYPICAL BAG DATA

Bag	Mass kg	Activity mr/h	Moisture	Composition % Plastic	% Paper	% Other	Comments
101	6.0	0.2	No	90		10	metal
102	7.5	0.2	No		90	10	metal
103	5.0	0.2	No	20	50	30	metal paint cans and trays
104	3.0	0.2	No	50	40	10	
105	4.0	0.2	No		50	50	metal paint cans
106	4.0	0.2	No	30	60	10	floor sweepings
107	5.0	0.2	No	90	5	5	rubber gloves
108	4.0	0.5	No	50	40	10	rubber
109	5.5	0.2	No	100			
110	5.0	0.2	No		50	50	floor sweepings
111	6.0	10.0	No	40	20	40	metal can, cotton mop
112	4.5	0.2	No	90	10		
113	8.0	0.2	Slight		20	80	wire, cotton mop
114	5.0	0.5	No	90	10		
115	8.5	0.2	No		10	90	paint cans
116	3.5	0.2	No			100	furnace filters
117	6.0	0.2	No	50	50		
118	2.0	0.2	No	80	10	10	metal cans
119	5.0	0.2	No	20	60	20	metal
120	3.0	0.2	No	50	50		
121	3.5	0.2	No			100	filters
122	3.0	0.2	No	50	20	30	vermiculite
123	5.0	0.2	No	100			green garbage bag
124	3.5	0.2	No	40	40	20	rubber gloves, vermiculite
125	5.0	0.2	No	30	20	50	cotton, wood
126	8.0	0.2	No			100	rubber suit
127	3.5	0.2	No			100	furnace filters
128	6.0	0.2	No	100			black garbage bag
129	6.0	0.2	No	10	50	40	rubber, paint cans

APPENDIX 2

BALE ACTIVITY

BALED WASTE CHARACTERIZATION
BALE NO.14

BAG CDR.	<1MR/H	1-10MR/H	11-100MR/H	>100MR/H
	51	9	5	0
BAG CDR IN BALE	78	14	8	0

BALE CDR	SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
MR/H	12	9	3	7	3	13

ISOTOPE	T1/2(Y)	ACTIVITY IN MILLICURIES SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
124 Sb	0.16						
60 Co	5.00	0.8	0.5	0.3	0.5	0.3	0.54
59 Fe	0.12						
54 Mn	1.00						
134 Cs	2.00	0.44	0.12	0.15	0.1	0.26	0.1
95 Nb	0.10	1.42	1	0.07	0.5	0.26	1.34
95 Zr	0.18	0.44	0.5	0.16	0.3	0.3	0.65
137 Cs	30.00	1.95	0.5	0.4	0.5	0.4	1.05
106 Ru	1.00	1.24	0.5	0.9	1.7	0.3	1.3
103 Ru	0.11	0.19	0.18		0.02	0.05	0.2
TOTALS		6.48	3.3	1.98	3.62	1.87	5.18

DECAY CORRECTION WITH TIME

ISOTOPE	0 Years AVG	0 Years FRACTION ACTIVITY/0	1 Year AVG	1 Year FRACTION ACTIVITY/0	5 Years AVG	5 Years FRACTION ACTIVITY/0	10 Years AVG	10 Years FRACTION ACTIVITY/0
124 Sb	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
60 Co	4.90E-01	0.13	4.27E-01	0.23	2.45E-01	0.24	1.23E-01	0.16
59 Fe	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
54 Mn	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
134 Cs	1.95E-01	0.05	1.38E-01	0.07	3.45E-02	0.03	6.10E-03	0.01
95 Nb	7.65E-01	0.20	5.56E-04	.00	1.55E-16	.00	3.14E-32	.00
95 Zr	3.92E-01	0.10	8.00E-03	.00	1.39E-09	.00	4.93E-18	.00
137 Cs	8.00E-01	0.21	7.82E-01	0.42	7.13E-01	0.70	6.35E-01	0.83
106 Ru	9.90E-01	0.26	4.95E-01	0.27	3.10E-02	0.03	9.68E-04	.00
103 Ru	1.07E-01	0.03	1.91E-04	.00	1.98E-15	.00	3.67E-29	.00
TOTALS	3.74E+00	1.00	1.85E+00	1.00	1.02E+00	1.00	7.65E-01	1.00

BALE ACTIVITY

BALED WASTE CHARACTERIZATION
BALE NO.16

BAG CDR.	<1MR/H	1-10MR/H	11-100MR/H	>100MR/H
	45	7	3	0
BAG CDR IN BALE	82	13	5	0

BALE CDR MR/H	SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
	35	28	5	16	4	28

ISOTOPE	T1/2(Y)	ACTIVITY IN MILLICURIES SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
124 Sb	0.16	0.02		0.02	0.02	0.01	1.6
60 Co	5.00	2.4	2.2	0.75	1	0.86	2.65
59 Fe	0.12	0.3	0.23	0.04	0.06	0.08	0.14
54 Mn	1.00	0.05					
134 Cs	2.00	0.23	0.16	0.14	0.16	0.04	0.3
95 Nb	0.10	1.15	0.75	0.57	0.77	0.26	1.3
95 Zr	0.18	0.53	0.45	0.27	0.38	0.13	0.67
137 Cs	30.00	1.14	0.6	0.6	0.8	0.4	2.1
106 Ru	1.00	1.76	1.2	1	0.9	0.1	1.5
103 Ru	0.11						
TOTALS		7.58	5.59	3.39	4.09	1.88	10.26

DECAY CORRECTION WITH TIME

ISOTOPE	0 Years AVG	0 Years FRACTION ACTIVITY/0	1 Year AVG	1 Year FRACTION ACTIVITY/0	5 Years AVG	5 Years FRACTION ACTIVITY/0	10 Years AVG	10 Years FRACTION ACTIVITY/0
124 Sb	2.78E-01	0.05	4.11E-03	.00	1.95E-10	.00	1.37E-19	.00
60 Co	1.64E+00	0.30	1.43E+00	0.47	8.22E-01	0.48	4.11E-01	0.35
59 Fe	1.42E-01	0.03	5.13E-04	.00	8.82E-14	.00	5.49E-26	.00
54 Mn	8.33E-03	.00	4.17E-03	.00	2.61E-04	.00	8.15E-06	.00
134 Cs	1.72E-01	0.03	1.21E-01	0.04	3.04E-02	0.02	5.37E-03	.00
95 Nb	8.00E-01	0.15	5.81E-04	.00	1.62E-16	.00	3.29E-32	.00
95 Zr	4.05E-01	0.07	8.27E-03	.00	1.44E-09	.00	5.09E-18	.00
137 Cs	9.40E-01	0.17	9.19E-01	0.30	8.37E-01	0.49	7.46E-01	0.64
106 Ru	1.08E+00	0.20	5.38E-01	0.18	3.37E-02	0.02	1.05E-03	.00
103 Ru	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
TOTALS	5.47E+00	1.00	3.03E+00	1.00	1.72E+00	1.00	1.16E+00	1.00

APPENDIX 2 (Cont'd)

BALED WASTE CHARACTERIZATION
BALE NO.17

BAG CDR.	<1MR/H	1-10MR/H	11-100MR/H	>100MR/H
	53	4	1	1
BAG CDR IN BALE	90	7	2	2

BALE CDR	SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
MR/H	3	3	1	1	1	7

ISOTOPE	T1/2(Y)	ACTIVITY IN MILLICURIES SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
124 Sb	0.16						
60 Co	5.00	0.097	0.09	0.025	0.034	0.09	0.06
59 Fe	0.12						
54 Mn	1.00						
134 Cs	2.00	0.011	0.08	0.08	0.06	0.02	0.23
95 Nb	0.10	0.071	0.6	0.48	0.34	0.1	1.16
95 Zr	0.18	0.034	0.28	0.21	0.16	0.05	0.55
137 Cs	30.00	3.11	0.22	0.2	0.18	0.08	0.59
106 Ru	1.00	1.06	0.79	0.65	0.53	0.18	2.24
103 Ru	0.11	0.02	0.41	0.02	0.01	0.01	0.08
TOTALS		4.403	2.47	1.665	1.314	0.53	4.91

DECAY CORRECTION WITH TIME

ISOTOPE	0 Years AVG	0 Years FRACTION ACTIVITY/0	1 Year AVG	1 Year FRACTION ACTIVITY/0	5 Years AVG	5 Years FRACTION ACTIVITY/0	10 Years AVG	10 Years FRACTION ACTIVITY/0
124 Sb	0.00	0.00	0.000E+00	0.00	0.000E+00	0.00	0.000E+00	0.00
60 Co	0.07	0.03	5.746E-02	0.04	3.300E-02	0.05	1.650E-02	0.03
59 Fe	0.00	0.00	0.000E+00	0.00	0.000E+00	0.00	0.000E+00	0.00
54 Mn	0.00	0.00	0.000E+00	0.00	0.000E+00	0.00	0.000E+00	0.00
134 Cs	0.08	0.03	5.669E-02	0.04	1.418E-02	0.02	2.507E-03	.00
95 Nb	0.46	0.18	3.332E-04	.00	9.292E-17	.00	1.883E-32	.00
95 Zr	0.21	0.08	4.369E-03	.00	7.590E-10	.00	2.692E-18	.00
137 Cs	0.73	0.29	7.133E-01	0.55	6.504E-01	0.90	5.794E-01	0.97
106 Ru	0.91	0.36	4.542E-01	0.35	2.841E-02	0.04	8.884E-04	.00
103 Ru	0.09	0.04	1.644E-04	.00	1.701E-15	.00	3.156E-29	.00
TOTALS	2.55	1.00	1.287E+00	1.00	7.260E-01	1.00	5.993E-01	1.00

BALE ACTIVITY

BALED WASTE CHARACTERIZATION
BALE NO.21

BAG CDR.	<1MR/H	1-10MR/H	11-100MR/H	>100MR/H
	52	5	4	0
BAG CDR IN BALE	85	8	7	0

BALE CDR	SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
MR/H	22	5	3	35	8	55

ISOTOPE	T1/2(Y)	ACTIVITY IN MILLICURIES SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
124 Sb	0.16						
60 Co	5.00	3	1	0.7	5.5	2.5	5
59 Fe	0.12						
54 Mn	1.00		0.04		0.12	0.05	0.1
134 Cs	2.00	0.07	0.02		0.03		
95 Nb	0.10	0.4	0.6	0.3	0.8	0.4	1
95 Zr	0.18	0.2	0.3	0.1	0.5	0.1	0.6
137 Cs	30.00	0.33	0.15	0.1	0.32	0.23	0.32
106 Ru	1.00		0.4	0.12	1.3	0.6	1.44
103 Ru	0.11					0.5	0.02
TOTALS		4	2.51	1.32	8.57	4.38	8.48

DECAY CORRECTION WITH TIME

ISOTOPE	0 Years AVG	0 Years FRACTION ACTIVITY/0	1 Year AVG	1 Year FRACTION ACTIVITY/0	5 Years AVG	5 Years FRACTION ACTIVITY/0	10 Years AVG	10 Years FRACTION ACTIVITY/0
124 Sb	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
60 Co	2.95E+00	0.60	2.57E+00	0.81	1.48E+00	0.86	7.38E-01	0.79
59 Fe	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
54 Mn	5.17E-02	0.01	2.58E-02	0.01	1.62E-03	.00	5.05E-05	.00
134 Cs	2.00E-02	.00	1.41E-02	.00	3.54E-03	.00	6.25E-04	.00
95 Nb	5.83E-01	0.12	4.24E-04	.00	1.18E-16	.00	2.40E-32	.00
95 Zr	3.00E-01	0.06	6.12E-03	.00	1.06E-09	.00	3.77E-18	.00
137 Cs	2.42E-01	0.05	2.36E-01	0.07	2.15E-01	0.13	1.92E-01	0.21
106 Ru	6.43E-01	0.13	3.22E-01	0.10	2.01E-02	0.01	6.29E-04	.00
103 Ru	8.67E-02	0.02	1.55E-04	.00	1.61E-15	.00	2.98E-29	.00
TOTALS	4.86E+00	1.00	3.17E+00	1.00	1.72E+00	1.00	9.31E-01	1.00

APPENDIX 2 (contd)

BALE ACTIVITY

BALED WASTE CHARACTERIZATION
BALE NO.22

BAG CDR.	<1MR/H	1-10MR/H	11-100MR/H	>100MR/H
	43	5	2	2
BAG CDR IN BALE	83	10	4	4

BALE CDR	SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
MR/H	15	6	4	180	8	23

ISOTOPE	T1/2(Y)	ACTIVITY IN MILLICURIES SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
124 Sb	0.16						
60 Co	5.00	1.54	1.03	1.5	6.14	1.9	4.54
59 Fe	0.12						
54 Mn	1.00	0.05		0.04	0.2		
134 Cs	2.00	0.25	0.03	0.11	0.11	0.06	0.1
95 Nb	0.10	1.96	0.21	1	2.27	1.03	0.1
95 Zr	0.18	1.3	0.1	0.52	1.32	0.6	2.02
137 Cs	30.00	1	0.1	0.33	0.72	0.3	1.1
106 Ru	1.00	1		0.3	3.74	0.74	0.5
103 Ru	0.11						
TOTALS		7.1	1.47	3.8	15	4.63	8.36

DECAY CORRECTION WITH TIME

ISOTOPE	0 Years AVG	0 Years FRACTION ACTIVITY/0	1 Year AVG	1 Year FRACTION ACTIVITY/0	5 Years AVG	5 Years FRACTION ACTIVITY/0	10 Years AVG	10 Years FRACTION ACTIVITY/0
124 Sb	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
60 Co	2.78E+00	0.41	2.42E+00	0.66	1.39E+00	0.70	6.94E-01	0.59
59 Fe	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
54 Mn	4.83E-02	0.01	2.42E-02	0.01	1.51E-03	.00	4.73E-05	.00
134 Cs	1.10E-01	0.02	7.78E-02	0.02	1.95E-02	0.01	3.44E-03	.00
95 Nb	1.18E+00	0.18	8.56E-04	.00	2.39E-16	.00	4.84E-32	.00
95 Zr	9.77E-01	0.15	1.99E-02	0.01	3.46E-09	.00	1.23E-17	.00
137 Cs	5.92E-01	0.09	5.78E-01	0.16	5.27E-01	0.27	4.70E-01	0.40
106 Ru	1.05E+00	0.16	5.23E-01	0.14	3.27E-02	0.02	1.02E-03	.00
103 Ru	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
TOTALS	6.73E+00	1.00	3.64E+00	1.00	1.97E+00	1.00	1.17E+00	1.00

BALE ACTIVITY

BALED WASTE CHARACTERIZATION
BALE NO.31

BAG CDR.	<1MR/H	1-10MR/H	11-100MR/>	100MR/H
	48	4	2	0
BAG CDR IN BALE	89	7	4	0

BALE CDR MR/H	SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
	3	7	1	2	8	20

ISOTOPE	T1/2(Y)	ACTIVITY IN MILLICURIES SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
124 Sb	0.16	1				0.01	
60 Co	5.00		0.23	0.13	0.23	0.5	0.5
59 Fe	0.12						
54 Mn	1.00						
134 Cs	2.00	0.05	0.21	0.02	0.03	0.44	0.7
95 Nb	0.10	0.23	0.33	0.03	0.17	0.81	1.03
95 Zr	0.18	0.11	0.11	0.01	0.11	0.44	0.5
137 Cs	30.00	0.21	0.6	0.08	0.08	1.3	2.1
106 Ru	1.00	0.55	1.7		0.2	3.75	4.9
103 Ru	0.11	0.04			0.01	0.05	
TOTALS		2.19	3.18	0.27	0.83	7.3	9.73

DECAY CORRECTION WITH TIME

ISOTOPE	0 Years AVG	0 Years FRACTION ACTIVITY/0	1 Year AVG	1 Year FRACTION ACTIVITY/0	5 Years AVG	5 Years FRACTION ACTIVITY/0	10 Years AVG	10 Years FRACTION ACTIVITY/0
124 Sb	1.68E-01	0.04	2.48E-03	.00	1.18E-10	.00	8.27E-20	.00
60 Co	2.65E-01	0.07	2.31E-01	0.11	1.33E-01	0.15	6.63E-02	0.10
59 Fe	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
54 Mn	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
134 Cs	2.42E-01	0.06	1.71E-01	0.08	4.27E-02	0.05	7.56E-03	0.01
95 Nb	4.33E-01	0.11	3.15E-04	.00	8.78E-17	.00	1.78E-32	.00
95 Zr	2.13E-01	0.05	4.36E-03	.00	7.57E-10	.00	2.68E-18	.00
137 Cs	7.28E-01	0.19	7.12E-01	0.35	6.49E-01	0.74	5.78E-01	0.88
106 Ru	1.85E+00	0.47	9.25E-01	0.45	5.79E-02	0.07	1.81E-03	.00
103 Ru	1.67E-02	.00	2.99E-05	.00	3.09E-16	.00	5.74E-30	.00
TOTALS	3.92E+00	1.00	2.05E+00	1.00	8.82E-01	1.00	6.54E-01	1.00

BALED WASTE CHARACTERIZATION
BALE NO.32

BAG CDR.	<1MR/H	1-10MR/H	11-100MR/>	100MR/H
	38	14	5	0
BAG CDR IN BALE	67	25	9	0

BALE CDR	SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
MR/H	60	20	30	9	5	20

ISOTOPE	T1/2(Y)	ACTIVITY IN MILLICURIES SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
124 Sb	0.16	0.02	0.02		0.02		0.01
60 Co	5.00	3.16	2.57	1.11	0.9	1.86	2.79
59 Fe	0.12						
54 Mn	1.00						
134 Cs	2.00	0.14	0.07	0.18	0.14	0.07	0.17
95 Nb	0.10	1.42	0.19	0.4	1.69	0.45	1.83
95 Zr	0.18	0.77	0.15	1.16	0.88	0.21	0.94
137 Cs	30.00	0.7	0.2	0.82	0.63	0.2	0.72
106 Ru	1.00	1.82	0.3	1.7	1.3	0.82	
103 Ru	0.11	0.34		0.7	0.41	0.1	0.43
TOTALS		8.37	3.5	6.07	5.97	3.71	6.89

DECAY CORRECTION WITH TIME

ISOTOPE	0 Years AVG	0 Years FRACTION ACTIVITY/0	1 Year AVG	1 Year FRACTION ACTIVITY/0	5 Years AVG	5 Years FRACTION ACTIVITY/0	10 Years AVG	10 Years FRACTION ACTIVITY/0
124 Sb	1.17E-02	.00	1.72E-04	.00	8.18E-12	.00	5.73E-21	.00
60 Co	2.07E+00	0.36	1.80E+00	0.61	1.03E+00	0.66	5.16E-01	0.54
59 Fe	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
54 Mn	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
134 Cs	1.28E-01	0.02	9.08E-02	0.03	2.27E-02	0.01	4.01E-03	.00
95 Nb	9.97E-01	0.17	7.24E-04	.00	2.02E-16	.00	4.09E-32	.00
95 Zr	6.85E-01	0.12	1.40E-02	.00	2.43E-09	.00	8.62E-18	.00
137 Cs	5.45E-01	0.09	5.33E-01	0.18	4.86E-01	0.31	4.33E-01	0.45
106 Ru	9.90E-01	0.17	4.95E-01	0.17	3.10E-02	0.02	9.68E-04	.00
103 Ru	3.30E-01	0.06	5.92E-04	.00	6.12E-15	.00	1.14E-28	.00
TOTALS	5.75E+00	1.00	2.93E+00	1.00	1.57E+00	1.00	9.54E-01	1.00

APPENDIX 2 (contd)

BALE ACTIVITY

BALED WASTE CHARACTERIZATION
BALE NO.33

BAG CDR.	<1MR/H	1-10MR/H	11-100MR/>	100MR/H
	62	4	3	0
BAG CDR IN BALE	90	6	4	0

BALE CDR MR/H	SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
	4	4	2	2	2	17

ISOTOPE	T1/2(Y)	ACTIVITY IN MILLICURIES SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
124 Sb	0.16						
60 Co	5.00	0.56	0.84	0.37	0.12	0.23	1.8
59 Fe	0.12	0.04	0.03		0.01	0.01	0.06
54 Mn	1.00						
134 Cs	2.00	0.06	0.02		0.02		
95 Nb	0.10	0.54	0.22	0.13	0.4	0.25	0.26
95 Zr	0.18	0.24	0.13	0.05	0.1	0.13	0.16
137 Cs	30.00	0.2	0.1	0.05	0.05	0.14	0.12
106 Ru	1.00	0.06	0.03		0.12		
103 Ru	0.11	0.09	0.04	0.02	0.04		
TOTALS		1.79	1.41	0.62	0.86	1.26	2.4

DECAY CORRECTION WITH TIME

ISOTOPE	0 Years AVG	0 Years FRACTION ACTIVITY/0	1 Year AVG	1 Year FRACTION ACTIVITY/0	5 Years AVG	5 Years FRACTION ACTIVITY/0	10 Years AVG	10 Years FRACTION ACTIVITY/0
124 Sb	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
60 Co	7.37E-01	0.53	6.41E-01	0.82	3.68E-01	0.78	1.84E-01	0.68
59 Fe	2.50E-02	0.02	9.05E-05	.00	1.56E-14	.00	9.69E-27	.00
54 Mn	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
134 Cs	1.67E-02	0.01	1.18E-02	0.02	2.95E-03	0.01	5.21E-04	.00
95 Nb	3.00E-01	0.22	2.18E-04	.00	6.08E-17	.00	1.23E-32	.00
95 Zr	1.35E-01	0.10	2.76E-03	.00	4.79E-10	.00	1.70E-18	.00
137 Cs	1.10E-01	0.08	1.07E-01	0.14	9.80E-02	0.21	8.73E-02	0.32
106 Ru	3.50E-02	0.03	1.75E-02	0.02	1.09E-03	.00	3.42E-05	.00
103 Ru	3.17E-02	0.02	5.68E-05	.00	5.88E-16	.00	1.09E-29	.00
TOTALS	1.39E+00	1.00	7.81E-01	1.00	4.70E-01	1.00	2.72E-01	1.00

BALED WASTE CHARACTERIZATION
BALE NO.37

BAG CDR.	<1MR/H	1-10MR/H	11-100MR/H	>100MR/H
	35	4	1	1
BAG CDR IN BALE	85	10	2	2

BALE CDR	SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
MR/H	12	40	3	9	12	15

ISOTOPE	T1/2(Y)	ACTIVITY IN MILLICURIES SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
124 Sb	0.16	0.024	0.09			0.06	0.038
60 Co	5.00	1.29	1.21	0.32	0.71	2.07	1.83
59 Fe	0.12						
54 Mn	1.00	0.05	0.07			0.12	0.06
134 Cs	2.00	0.18	0.12	0.005	0.16	0.27	0.16
95 Nb	0.10	0.5	2.8	0.08	0.61	1.5	0.97
95 Zr	0.18	0.26	1.44	0.04	0.43	0.74	0.46
137 Cs	30.00	0.55	0.51	0.04	0.58	0.95	0.6
106 Ru	1.00	2.53	0.78		2.16	3.17	2.37
103 Ru	0.11		0.36			0.29	0.06
TOTALS		5.384	7.38	0.485	4.65	9.17	6.548

DECAY CORRECTION WITH TIME

ISOTOPE	0 Years AVG	0 Years FRACTION ACTIVITY/0	1 Year AVG	1 Year FRACTION ACTIVITY/0	5 Years AVG	5 Years FRACTION ACTIVITY/0	10 Years AVG	10 Years FRACTION ACTIVITY/0
124 Sb	3.53E-02	0.01	5.22E-04	.00	2.48E-11	.00	1.74E-20	.00
60 Co	1.24E+00	0.22	1.08E+00	0.40	6.19E-01	0.52	3.10E-01	0.42
59 Fe	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
54 Mn	5.00E-02	0.01	2.50E-02	0.01	1.56E-03	.00	4.89E-05	.00
134 Cs	1.49E-01	0.03	1.05E-01	0.04	2.64E-02	0.02	4.66E-03	0.01
95 Nb	1.08E+00	0.19	7.82E-04	.00	2.18E-16	.00	4.42E-32	.00
95 Zr	5.62E-01	0.10	1.15E-02	.00	1.99E-09	.00	7.06E-18	.00
137 Cs	5.38E-01	0.10	5.26E-01	0.20	4.80E-01	0.41	4.27E-01	0.57
106 Ru	1.84E+00	0.33	9.18E-01	0.34	5.74E-02	0.05	1.79E-03	.00
103 Ru	1.18E-01	0.02	2.12E-04	.00	2.20E-15	.00	4.07E-29	.00
TOTALS	5.60E+00	1.00	2.67E+00	1.00	1.18E+00	1.00	7.43E-01	1.00

APPENDIX 2 (contd)

BALE ACTIVITY

BALED WASTE CHARACTERIZATION
BALE NO.39

BAG CDR.	<1MR/H	1-10MR/H	11-100MR/H	>100MR/H
	44	5	5	0
BAG CDR IN BALE	81	9	9	0

BALE CDR MR/H	SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
	15	4	4	6	5	10

ISOTOPE	T1/2(Y)	ACTIVITY IN MILLICURIES SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
124 Sb	0.16	0.06	0.01	0.01	0.1	0.06	0.13
60 Co	5.00	1.13	0.55	0.33	1	0.74	1.2
59 Fe	0.12						
54 Mn	1.00						
134 Cs	2.00	0.63	0.15	0.15	0.01	0.01	0.16
95 Nb	0.10	0.4	0.14	0.2	0.16	0.15	
95 Zr	0.18	0.23	0.1	0.1	0.17	0.1	0.1
137 Cs	30.00	3.6	1.25	0.77	0.1	0.04	1.24
106 Ru	1.00	0.6	0.2	0.3	0.8	1.11	
103 Ru	0.11						
TOTALS		6.65	2.4	1.86	2.34	2.21	2.83

DECAY CORRECTION WITH TIME

ISOTOPE	0 Years AVG	0 Years FRACTION ACTIVITY/0	1 Year AVG	1 Year FRACTION ACTIVITY/0	5 Years AVG	5 Years FRACTION ACTIVITY/0	10 Years AVG	10 Years FRACTION ACTIVITY/0
124 Sb	6.17E-02	0.02	9.10E-04	.00	4.32E-11	.00	3.03E-20	.00
60 Co	8.25E-01	0.27	7.18E-01	0.32	4.13E-01	0.27	2.06E-01	0.18
59 Fe	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
54 Mn	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
134 Cs	1.85E-01	0.06	1.31E-01	0.06	3.27E-02	0.02	5.79E-03	0.01
95 Nb	1.75E-01	0.06	1.27E-04	.00	3.55E-17	.00	7.19E-33	.00
95 Zr	1.33E-01	0.04	2.72E-03	.00	4.73E-10	.00	1.68E-18	.00
137 Cs	1.17E+00	0.38	1.14E+00	0.51	1.04E+00	0.69	9.26E-01	0.81
106 Ru	5.02E-01	0.16	2.51E-01	0.11	1.57E-02	0.01	4.91E-04	.00
103 Ru	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
TOTALS	3.05E+00	1.00	2.24E+00	1.00	1.50E+00	1.00	1.14E+00	1.00

BALED WASTE CHARACTERIZATION
BALE NO.42

BAG COR.	<1MR/H	1-10MR/H	11-100MR/H	>100MR/H
	49	5	2	0
BAG COR IN BALE	88	9	4	0

BALE COR	SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
MR/H	10	2	3	2	2	8

ISOTOPE	T1/2(Y)	ACTIVITY IN MILLICURIES SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
124 Sb	0.16	0.01				0.01	0.01
60 Co	5.00	0.4	0.02	0.41	0.12	0.12	0.3
59 Fe	0.12						
54 Mn	1.00	0.43	0.01	0.02		0.01	0.02
134 Cs	2.00	0.05	0.02	0.003	0.05	0.06	0.07
95 Nb	0.10	1.2	0.35	0.1	0.4	0.42	0.97
95 Zr	0.18	0.63	0.18	0.11	0.12	0.2	0.55
137 Cs	30.00	0.32	0.1	0.02	0.48	0.51	0.41
106 Ru	1.00	0.32	0.5	0.2	0.03	0.2	0.44
103 Ru	0.11	0.21	0.05			0.05	0.16
TOTALS		3.57	1.23	0.863	1.2	1.58	2.93

DECAY CORRECTION WITH TIME

ISOTOPE	0 Years AVG	0 Years FRACTION ACTIVITY/0	1 Year AVG	1 Year FRACTION ACTIVITY/0	5 Years AVG	5 Years FRACTION ACTIVITY/0	10 Years AVG	10 Years FRACTION ACTIVITY/0
124 Sb	5.00E-03	.00	7.38E-05	.00	3.50E-12	.00	2.46E-21	.00
60 Co	2.28E-01	0.12	1.99E-01	0.28	1.14E-01	0.28	5.71E-02	0.19
59 Fe	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
54 Mn	8.17E-02	0.04	4.08E-02	0.06	2.55E-03	0.01	7.99E-05	.00
134 Cs	4.22E-02	0.02	2.98E-02	0.04	7.46E-03	0.02	1.32E-03	.00
95 Nb	5.73E-01	0.30	4.17E-04	.00	1.16E-16	.00	2.35E-32	.00
95 Zr	2.98E-01	0.16	6.09E-03	0.01	1.06E-09	.00	3.75E-18	.00
137 Cs	3.07E-01	0.16	3.00E-01	0.42	2.73E-01	0.67	2.43E-01	0.81
106 Ru	2.82E-01	0.15	1.41E-01	0.20	8.81E-03	0.02	2.75E-04	.00
103 Ru	7.83E-02	0.04	1.40E-04	.00	1.45E-15	.00	2.70E-29	.00
TOTALS	1.90E+00	1.00	7.17E-01	1.00	4.06E-01	1.00	3.02E-01	1.00

BALE ACTIVITY

BALED WASTE CHARACTERIZATION
BALE NO.53

BAG CDR.	<1MR/H	1-10MR/H	11-100MR/H	>100MR/H
	51	9	0	1
BAG CDR IN BALE	84	15	0	2

BALE CDR MR/H	SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
	4	60	2	2	4	12

ISOTOPE	T1/2(Y)	ACTIVITY IN MILLICURIES SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
124 Sb	0.16						
60 Co	5.00	0.6	3.8	0.4	0.3	0.5	2.1
59 Fe	0.12						
54 Mn	1.00						
134 Cs	2.00	0.05		0.03	0.01	0.04	
95 Nb	0.10	0.05	0.09	0.04	0.05	0.06	0.14
95 Zr	0.18					0.06	0.07
137 Cs	30.00	0.3	0.1	0.24	0.1	0.1	0.18
106 Ru	1.00						
103 Ru	0.11						
TOTALS		1	3.99	0.71	0.46	0.76	2.49

DECAY CORRECTION WITH TIME

ISOTOPE	0 Years AVG	0 Years FRACTION ACTIVITY/0	1 Year AVG	1 Year FRACTION ACTIVITY/0	5 Years AVG	5 Years FRACTION ACTIVITY/0	10 Years AVG	10 Years FRACTION ACTIVITY/0
124 Sb	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
60 Co	1.28E+00	0.82	1.12E+00	0.86	6.42E-01	0.81	3.21E-01	0.70
59 Fe	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
54 Mn	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
134 Cs	2.17E-02	0.01	1.53E-02	0.01	3.83E-03	.00	6.78E-04	.00
95 Nb	7.17E-02	0.05	5.21E-05	.00	1.45E-17	.00	2.94E-33	.00
95 Zr	2.17E-02	0.01	4.42E-04	.00	7.68E-11	.00	2.73E-19	.00
137 Cs	1.70E-01	0.11	1.66E-01	0.13	1.51E-01	0.19	1.35E-01	0.30
106 Ru	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
103 Ru	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
TOTALS	1.57E+00	1.00	1.30E+00	1.00	7.97E-01	1.00	4.57E-01	1.00

BALED WASTE CHARACTERIZATION
BALE NO.54

BAG COR.	<1MR/H	1-10MR/H	11-100MR/>	100MR/H
	40	1	1	1
BAG COR IN BALE	93	2	2	2

BALE COR	SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
MR/H	40	45	6	3	5	15

ISOTOPE	T1/2(Y)	ACTIVITY IN MILLICURIES SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
124 Sb	0.16	0.016	0.033				
60 Co	5.00	3.06	2.32	0.6	0.5	1.06	1.97
59 Fe	0.12	0.32	0.11	0.05	0.04	0.1	0.16
54 Mn	1.00	0.11	0.04				0.06
134 Cs	2.00	0.07	0.22		0.03	0.05	0.07
95 Nb	0.10	0.63	0.73	0.10	0.04	0.29	0.61
95 Zr	0.18	0.43	0.34	0.1		0.16	0.21
137 Cs	30.00	0.3	1.12	0.04	0.21	0.10	0.26
106 Ru	1.00	0.57	2.21		0.5	0.04	0.40
103 Ru	0.11	0.12	0.39			0.07	
TOTALS		5.616	7.513	0.97	1.32	1.95	3.82

DECAY CORRECTION WITH TIME

ISOTOPE	0 Years AVG	0 Years FRACTION ACTIVITY/0	1 Year AVG	1 Year FRACTION ACTIVITY/0	5 Years AVG	5 Years FRACTION ACTIVITY/0	10 Years AVG	10 Years FRACTION ACTIVITY/0
124 Sb	8.17E-03	.00	1.21E-04	.00	5.72E-12	.00	4.01E-21	.00
60 Co	1.58E+00	0.45	1.38E+00	0.65	7.92E-01	0.70	3.96E-01	0.58
59 Fe	1.30E-01	0.04	4.71E-04	.00	8.09E-14	.00	5.04E-26	.00
54 Mn	3.50E-02	0.01	1.75E-02	0.01	1.09E-03	.00	3.42E-05	.00
134 Cs	7.33E-02	0.02	5.19E-02	0.02	1.30E-02	0.01	2.29E-03	.00
95 Nb	4.13E-01	0.12	3.00E-04	.00	8.38E-17	.00	1.70E-32	.00
95 Zr	2.07E-01	0.06	4.22E-03	.00	7.33E-10	.00	2.60E-18	.00
137 Cs	3.52E-01	0.10	3.44E-01	0.16	3.13E-01	0.28	2.79E-01	0.41
106 Ru	6.33E-01	0.18	3.17E-01	0.15	1.98E-02	0.02	6.19E-04	.00
103 Ru	9.67E-02	0.03	1.73E-04	.00	1.79E-15	.00	3.33E-29	.00
TOTALS	3.53E+00	1.00	2.11E+00	1.00	1.14E+00	1.00	6.78E-01	1.00

BALED WASTE CHARACTERIZATION
BALE NO.55

BAG CDR.	<1MR/H	1-10MR/H	11-100MR/H	>100MR/H
	48	5	1	1
BAG CDR IN BALE	87	9	2	2

BALE CDR MR/H	SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
	6	3	1	3	5	4

ISOTOPE	T1/2(Y)	ACTIVITY IN MILLICURIES SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
124 Sb	0.16						
60 Co	5.00	1.43	0.31	0.12	0.13	0.67	0.57
59 Fe	0.12						
54 Mn	1.00						
134 Cs	2.00	0.08	0.03	0.12	0.2	0.15	0.1
95 Nb	0.10	0.07	0.03	0.01	0.03	0.05	0.04
95 Zr	0.18			0.03	0.05	0.06	
137 Cs	30.00	2.23	0.34	0.11	0.42	0.67	0.5
106 Ru	1.00						
103 Ru	0.11						
TOTALS		3.81	0.71	0.39	0.83	1.58	1.21

DECAY CORRECTION WITH TIME

ISOTOPE	0 Years AVG	0 Years FRACTION ACTIVITY/0	1 Year AVG	1 Year FRACTION ACTIVITY/0	5 Years AVG	5 Years FRACTION ACTIVITY/0	10 Years AVG	10 Years FRACTION ACTIVITY/0
124 Sb	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
60 Co	5.38E-01	0.38	4.69E-01	0.38	2.69E-01	0.29	1.35E-01	0.19
59 Fe	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
54 Mn	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
134 Cs	1.10E-01	0.08	7.78E-02	0.06	1.95E-02	0.02	3.44E-03	.00
95 Nb	3.83E-02	0.03	2.79E-05	.00	7.77E-10	.00	1.57E-33	.00
95 Zr	2.33E-02	0.02	4.76E-04	.00	8.28E-11	.00	2.93E-19	.00
137 Cs	7.12E-01	0.50	6.95E-01	0.56	6.34E-01	0.69	5.65E-01	0.80
106 Ru	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
103 Ru	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
TOTALS	1.42E+00	1.00	1.24E+00	1.00	9.23E-01	1.00	7.03E-01	1.00

APPENDIX 2 (contd)

BALE ACTIVITY

BALED WASTE CHARACTERIZATION
BALE NO.81

BAG CDR.	<1MR/H	1-10MR/H	11-100MR/H	>100MR/H
	51	5	1	0
BAG CDR IN BALE	85	8	7	0

BALE CDR	SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
MR/H	13	6	1	2	5	15

ISOTOPE	T1/2(Y)	ACTIVITY IN MILLICURIES SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
124 Sb	0.16						
60 Co	5.00	1.4	0.81	0.24	0.32	0.96	1.22
59 Fe	0.12						
54 Mn	1.00	0.02		0.01			0.01
134 Cs	2.00	0.04	0.01	0.03	0.02		0.03
95 Nb	0.10	0.03	0.08	0.02	0.02		0.06
95 Zr	0.18	0.06	0.05	0.001	0.04		0.03
137 Cs	30.00	0.15	0.1	0.05	0.16	0.1	0.13
106 Ru	1.00						
103 Ru	0.11						
TOTALS		1.7	1.05	0.351	0.56	1.06	1.48

DECAY CORRECTION WITH TIME

ISOTOPE	0 Years AVG	0 Years FRACTION ACTIVITY/0	1 Year AVG	1 Year FRACTION ACTIVITY/0	5 Years AVG	5 Years FRACTION ACTIVITY/0	10 Years AVG	10 Years FRACTION ACTIVITY/0
124 Sb	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
60 Co	8.25E-01	0.80	7.18E-01	0.85	4.13E-01	0.79	2.06E-01	0.69
59 Fe	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
54 Mn	6.67E-03	0.01	3.33E-03	.00	2.08E-04	.00	6.52E-06	.00
134 Cs	2.17E-02	0.02	1.53E-02	0.02	3.83E-03	0.01	6.78E-04	.00
95 Nb	3.50E-02	0.03	2.54E-05	.00	7.09E-18	.00	1.44E-33	.00
95 Zr	3.02E-02	0.03	6.16E-04	.00	1.07E-10	.00	3.79E-19	.00
137 Cs	1.15E-01	0.11	1.12E-01	0.13	1.02E-01	0.20	9.13E-02	0.31
106 Ru	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
103 Ru	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
TOTALS	1.03E+00	1.00	8.50E-01	1.00	5.19E-01	1.00	2.98E-01	1.00

APPENDIX 2 (contd)

BALE ACTIVITY

BALED WASTE CHARACTERIZATION
BALE NO.82

BAG CDR.	<1MR/H	1-10MR/H	11-100MR/H	>100MR/H
	50	4	6	1
BAG CDR IN BALE	82	7	10	2

BALE CDR MR/H	SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
	60	180	3	6	65	35

ISOTOPE	T1/2(Y)	ACTIVITY IN MILLICURIES SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
124 Sb	0.16	0.01	0.07	0.01	0.01		0.07
60 Co	5.00	4	10.74	0.73	0.7	4.6	3.25
59 Fe	0.12						
54 Mn	1.00						
134 Cs	2.00	0.11	0.27	0.1	0.1		0.24
95 Nb	0.10	0.5	1.4	0.14	0.2	0.4	2.4
95 Zr	0.18	0.3	0.6	0.04	0.11	0.2	0.44
137 Cs	30.00	0.24	1.02	0.14	0.17	0.24	0.97
106 Ru	1.00	0.66	1.86	0.26	0.1	2.9	1.31
103 Ru	0.11						
TOTALS		5.82	15.96	1.42	1.39	8.34	8.68

DECAY CORRECTION WITH TIME

ISOTOPE	0 Years AVG	0 Years FRACTION ACTIVITY/0	1 Year AVG	1 Year FRACTION ACTIVITY/0	5 Years AVG	5 Years FRACTION ACTIVITY/0	10 Years AVG	10 Years FRACTION ACTIVITY/0
124 Sb	2.83E-02	.00	4.18E-04	.00	1.99E-11	.00	1.39E-20	.00
60 Co	4.00E+00	0.58	3.49E+00	0.75	2.00E+00	0.81	1.00E+00	0.73
59 Fe	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
54 Mn	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
134 Cs	1.37E-01	0.02	9.66E-02	0.02	2.42E-02	0.01	4.27E-03	.00
95 Nb	8.40E-01	0.12	6.10E-04	.00	1.70E-16	.00	3.45E-32	.00
95 Zr	2.82E-01	0.04	5.75E-03	.00	9.99E-10	.00	3.54E-18	.00
137 Cs	4.63E-01	0.07	4.53E-01	0.10	4.13E-01	0.17	3.68E-01	0.27
106 Ru	1.18E+00	0.17	5.91E-01	0.13	3.70E-02	0.01	1.16E-03	.00
103 Ru	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
TOTALS	6.94E+00	1.00	4.63E+00	1.00	2.48E+00	1.00	1.37E+00	1.00

APPENDIX 2 (contd)

BALE ACTIVITY

BALED WASTE CHARACTERIZATION
BALE NO.92

BAG CDR.	<1MR/H	1-10MR/H	11-100MR/H	>100MR/H
	47	5	5	0
BAG CDR IN BALE	82	9	9	0

BALE CDR MR/H	SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
	25	6	2	4	4	17

ISOTOPE	T1/2(Y)	ACTIVITY IN MILLICURIES SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
124 Sb	0.16						
60 Co	5.00	2	1.2	0.6	0.8	0.81	1.95
59 Fe	0.12						
54 Mn	1.00						
134 Cs	2.00			0.04	0.03	0.03	
95 Nb	0.10	0.28	0.1	0.02	0.05		0.09
95 Zr	0.18	0.03	0.05	0.02	0.03		0.04
137 Cs	30.00	0.11	0.1	0.17	0.13	0.14	0.4
106 Ru	1.00						
103 Ru	0.11						
TOTALS		2.42	1.45	0.85	1.04	0.98	2.48

DECAY CORRECTION WITH TIME

ISOTOPE	0 Years AVG	0 Years FRACTION ACTIVITY/0	1 Year AVG	1 Year FRACTION ACTIVITY/0	5 Years AVG	5 Years FRACTION ACTIVITY/0	10 Years AVG	10 Years FRACTION ACTIVITY/0
124 Sb	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
60 Co	1.23E+00	0.80	1.07E+00	0.85	6.13E-01	0.79	3.07E-01	0.69
59 Fe	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
54 Mn	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
134 Cs	1.67E-02	0.01	1.18E-02	0.01	2.95E-03	.00	5.21E-04	.00
95 Nb	9.00E-02	0.06	6.54E-05	.00	1.82E-17	.00	3.70E-33	.00
95 Zr	2.83E-02	0.02	6.03E-04	.00	1.24E-10	.00	5.39E-19	.00
137 Cs	1.75E-01	0.11	1.71E-01	0.14	1.56E-01	0.20	1.39E-01	0.31
106 Ru	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
103 Ru	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
TOTALS	1.54E+00	1.00	1.25E+00	1.00	7.72E-01	1.00	4.46E-01	1.00

APPENDIX 2 (concluded)

BALE ACTIVITY

BALED WASTE CHARACTERIZATION
BALE NO.93

BAG CDR.	<1MR/H	1-10MR/H	11-100MR/H	>100MR/H
	53	4	4	0
BAG CDR IN BALE	87	7	7	0

BALE CDR MR/H	SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
	10	3	7	11	5	11

ISOTOPE	T1/2(Y)	ACTIVITY IN MILLICURIES SIDE1	SIDE2	SIDE3	SIDE4	SIDE5	SIDE6
124 Sb	0.16						
60 Co	5.00	1.32	0.5	0.6	1.23	0.6	2.15
59 Fe	0.12						
54 Mn	1.00						
134 Cs	2.00	0.34	0.23	0.04	0.43	0.15	0.1
95 Nb	0.10	0.17	0.03	0.06	0.22	0.06	0.3
95 Zr	0.18	0.07	0.02	0.03	0.06	0.01	0.1
137 Cs	30.00	2.42	0.2	0.14	0.3	1.2	0.36
106 Ru	1.00	1.85	0.15		0.24	0.44	0.21
103 Ru	0.11						
TOTALS		6.17	1.13	0.87	2.48	2.46	3.22

DECAY CORRECTION WITH TIME

ISOTOPE	0 Years AVG	0 Years FRACTION ACTIVITY/0	1 Year AVG	1 Year FRACTION ACTIVITY/0	5 Years AVG	5 Years FRACTION ACTIVITY/0	10 Years AVG	10 Years FRACTION ACTIVITY/0
124 Sb	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
60 Co	1.07E+00	0.39	9.29E-01	0.45	5.33E-01	0.42	2.67E-01	0.30
59 Fe	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
54 Mn	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
134 Cs	2.15E-01	0.08	1.52E-01	0.07	3.80E-02	0.03	6.72E-03	0.01
95 Nb	1.40E-01	0.05	1.02E-04	.00	2.84E-17	.00	5.75E-33	.00
95 Zr	4.83E-02	0.02	9.87E-04	.00	1.71E-10	.00	6.08E-19	.00
137 Cs	7.70E-01	0.28	7.52E-01	0.36	6.86E-01	0.54	6.11E-01	0.69
106 Ru	4.82E-01	0.18	2.41E-01	0.12	1.51E-02	0.01	4.71E-04	.00
103 Ru	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
TOTALS	2.72E+00	1.00	2.08E+00	1.00	1.27E+00	1.00	8.85E-01	1.00

APPENDIX 3

STATISTICAL ANALYSIS OF TRITIUM AND CARBON-14 IN COMPACTABLE WASTE

The total waste examined consisted of 122 "wet" bags and 950 "dry" bags for a total of 1072 bags. These bags produced 18 bales or 9 m^3 waste. Fifty-one (51) "wet" and 8 "dry" bags were analyzed to determine their tritium content. As shown in Table A1 the tritium content of the bags was scattered widely.

Pool standard deviations for the "wet" (Spw) and "dry" (Spd) bags were estimated using:

$$Sp = \left(\frac{\Sigma Ni \; Si^2}{\Sigma Ni} \right)^{1/2}$$

where Ni is the number of bags with an $\bar{x}i$ content of tritium and Si is the standard deviation associated with this mean tritium content. The overall mean tritium contents of the "wet" and "dry" bags were calculated and the pool standard deviations used to develop confidence intervals about the mean values using the formula:

$$CI = \pm Sp \cdot t\alpha/\sqrt{N}$$

where N = number of data values and t is the t- score factor. Values for $t\alpha$ of 2.00 and 2.31 were used for the "wet" and "dry" bags respectively corresponding to the 95% confidence interval. This gave confidence intervals of ±13.34% about the 0.7107 Ci mean value for "wet" bags and ±15.1% about the mean value of 2.05 mCi for the "dry" bags.

The total tritium content of the 9 m^3 of waste was estimated by adding the tritium content of the "wet" bags (122 x 0.7107 Ci) to that of the "dry" bags (950 x 2.05 mCi). An overall confidence interval of ±14.9% around the total tritium was derived from:

$$CI_{ov} = \frac{Nw \cdot CI_w + Nd \cdot CId}{Nw + Nd}$$

where N is number of bags, CI confidence interval and w and d refer to "wet" and "dry". The total tritium content is then estimated at 88.653 Ci ± 14.9% or 75.445 to 101.863 Ci.

No of bags	Mean + SD $\bar{x}_i$	Pool Std Dev (Sp)	Overall Mean ^{3}H±CI
"Wet" 5	6.654±1.81 Ci	±0.5818 Ci	0.7107 Ci ± 13.3%
27	109.95±180.6 mCi		
19	458.8±275 µCi		
51			
"Dry" 4	3.68±0.43 mCi	±3.79x10^{-4} Ci	2.05 mCi ± 15.1%
4	422.8±320 µCi		
8			

A similar analysis of the carbon-14 data was done with the 4.2 µCi value discarded.

No of Bags	Mean + SD $\bar{x}_i$	Pool Std Dev (Sp)	Overall mean ^{14}C±CI
"Wet" 36	28.6±23.1 nCi	±68.96 nCi	66.67 nCi ± 32.6%
5	340.8±187.5 nCi		
41			
"Dry" 7	25.8±23.3 nCi	±23.3 nCi	25.8 nCi ± 80.5%

The overall confidence interval for carbon-14 was calculated to be ±75%. Using this value the carbon-14 content of 1 m^3 waste could be between 0.78 and 5.4 µCi. The high variation results from the "dry" bag values and more analysis of these bags will be needed to improve the confidence interval.

Tritium Analysis of Waste Bags

"Wet" Bags

µCi	mCi	Ci
100	1	4.04
156	1.04	5.4
158	1.12	7
178	1.5	7.5
228	1.63	9.3
228	2.4	
260	3.19	
310	3.3	
325	3.96	
329	3.96	
360	4.1	
583	4.23	
650	5.3	
661	5.6	
761	8.7	
795	17.1	
816	20.9	
850	26.1	
969	66	
	156	
	229	
	233	
	285	
	345	
	390	
	403	
	743	

Dry" Bags

µCi	mCi
169	3.2
228	3.3
325	4
969	4.2

Carbon-14 Analysis of Waste Bags

"Wet" Bags

nCi	µCi
1.3	4.2 *
2.8	
3.1	
3.8	
5.4	
5.5	
7	
7.1	
8	
12	
13	
13.4	
16	
17	
18	
18.1	
20	
20	
22	
24	
26	
27	
29.8	
33.8	
35	
36	
45	
47	
50	
50.5	
52	
62.3	
64.3	
71	
76	
87	
140	
140	
410	
504	
510	

"Dry" Bags

nCi
2.8
5.5
13.4
17
27
50.5
64.3

*The 4.2 µCi value was discarded for the analysis.

APPENDIX 4

BALE ACTIVITY DETERMINATION

BALE MANUFACTURE

Bale dimensions are 100 x 80 x 60 cm. For ease of gamma scanning the higher activity bags (>10 mr/h contact dose rate) were placed in the centre of the bale to obtain the best possible approximation to a point source.

Bale Examination

All six sides of each bale were scanned with a high purity planar germanium detector and multi-channel analyzer placed 100 cm from the bale. This gave distances from the centre of the bale of 130 cm, 140 cm or 150 cm depending on which side of the bale was being scanned.

The detector was calibrated with a mixed radionuclide source at 130 cm and 150 cm to obtain detector efficiency values for the different radionuclide energies at these distances. Efficiency at 140 cm was calculated from these values using the inverse square law.

Bale activity in millicuries was obtained from the following equation:

$$A = \frac{N}{G.E.S.3.7\times10^{7}}$$

where N = counts per second
G = gamma abundance. Values obtained from the Table of Isotopes, Lederer Hollander and Pearlman
E = detector efficiency
S = shielding factor. Calculated from mass absorption coefficients using a material density of 0.5 g/cm³. Reactor Shielding Design Manual - Rockwell.

G, E & S values used for the examinations were as follows:

Isotope	Gamma Abundance	Detector Efficiency (1.4 m)	Shielding Factors 30 cm	40 cm	50 cm
^{124}Sb	0.5	$9x10^{-8}$	0.49	0.38	0.3
^{60}Co	1	$1.27x10^{-7}$	0.44	0.33	0.25
^{59}Fe	0.44	$1.3x10^{-7}$	0.43	0.33	0.25
^{65}Zn	0.49	$1.65x10^{-7}$	0.41	0.3	0.22
^{54}Mn	1	$2.5x10^{-7}$	0.36	0.25	0.18
^{134}Cs	1	$2.65x10^{-7}$	0.34	0.24	0.17
^{137}Cs	0.85	$3.6x10^{-7}$	0.32	0.22	0.15
^{95}Nb	1	$2.85x10^{-7}$	0.34	0.24	0.17
^{95}Zr	0.49	$3.07x10^{-7}$	0.33	0.23	0.16
^{106}Ru	0.11	$4x10^{-7}$	0.31	0.21	0.14

POOR
QUALITY
ORIGINAL